

WHAT IS CLAIMED IS:

1. A liquid crystal display device comprising:

(a) a first substrate;

(b) a second substrate facing and spaced away from said first substrate;

(c) a liquid crystal layer sandwiched between said first and second substrates;

(d) a switching device formed on said first substrate;

(e) a first electrically insulating film randomly patterned on said first substrate;

(f) a second electrically insulating film covering said first electrically insulating film therewith, and having a wavy surface; and

(g) a reflection electrode formed on said second electrically insulating film, and electrically connected to an electrode of said switching device,

wherein a light passing through said second substrate and said liquid crystal layer is reflected at said reflection electrode,

said second electrically insulating film extends outwardly from said first electrically insulating film by a certain length at an end of a display region in which images are to be displayed, such that a step formed by said first and second electrically insulating films in the vicinity of said end of said display region is smoothed.

2. The liquid crystal display device as set forth in claim 1, wherein said certain length is in the range of about $10\text{ }\mu\text{m}$ to about $12\text{ }\mu\text{m}$ both inclusive.

3. The liquid crystal display device as set forth in claim 1, wherein said second electrically insulating film has a thickness in the range of about $0.3\text{ }\mu\text{m}$ to about $1.5\text{ }\mu\text{m}$ both inclusive.

4. The liquid crystal display device as set forth in claim 1, wherein said first electrically insulating film has a thickness in the range of about 1 μ m to about 3 μ m both inclusive.

5. The liquid crystal display device as set forth in claim 1, wherein said second electrically insulating film is composed of thermo-flexible organic or inorganic material.

6. The liquid crystal display device as set forth in claim 1, wherein said first and second electrically insulating films are composed of different materials from each other.

7. The liquid crystal display device as set forth in claim 1, wherein said first and second electrically insulating films are composed of the same material having different viscosities from each other.

8. The liquid crystal display device as set forth in claim 1, wherein said first and second electrically insulating films are composed of a combination of organic and inorganic materials.

9. A liquid crystal display device comprising:
(a) a first substrate;
(b) a second substrate facing and spaced away from said first substrate;
(c) a liquid crystal layer sandwiched between said first and second substrates;
(d) a switching device formed on said first substrate;
(e) a first electrically insulating film randomly patterned on said first substrate;
(f) a second electrically insulating film covering said first electrically

insulating film therewith, and having a wavy surface; and

(g) a reflection electrode formed on said second electrically insulating film, and electrically connected to an electrode of said switching device,

wherein a light passing through said second substrate and said liquid crystal
5 layer is reflected at said reflection electrode,

said second electrically insulating film extends inwardly from said first electrically insulating film by a certain length at a contact region where said reflection electrode is electrically connected to said electrode of said switching device, such that a step formed by said first and second electrically insulating
10 films in the vicinity of said contact region is smoothed.

10. The liquid crystal display device as set forth in claim 9, wherein said certain length is in the range of about $10\text{ }\mu\text{m}$ to about $12\text{ }\mu\text{m}$ both inclusive.

15 11. The liquid crystal display device as set forth in claim 9, wherein said second electrically insulating film has a thickness in the range of about $0.3\text{ }\mu\text{m}$ to about $1.5\text{ }\mu\text{m}$ both inclusive.

20 12. The liquid crystal display device as set forth in claim 9, wherein said first electrically insulating film has a thickness in the range of about $1\text{ }\mu\text{m}$ to about $3\text{ }\mu\text{m}$ both inclusive.

25 13. The liquid crystal display device as set forth in claim 9, wherein said second electrically insulating film is composed of thermo-flexible organic or inorganic material.

14. The liquid crystal display device as set forth in claim 9, wherein said first and second electrically insulating films are composed of different materials from each other.

15. The liquid crystal display device as set forth in claim 9, wherein said first and second electrically insulating films are composed of the same material having different viscosities from each other.

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16. The liquid crystal display device as set forth in claim 9, wherein said first and second electrically insulating films are composed of a combination of organic and inorganic materials.

10 17. A liquid crystal display device comprising:

(a) a first substrate;

(b) a second substrate facing and spaced away from said first substrate;

(c) a liquid crystal layer sandwiched between said first and second substrates;

15 (d) a switching device formed on said first substrate;

(e) an electrically insulating film formed on said first substrate, and defined by a thick region and a thin region, said electrically insulating film having a wavy surface; and

20 (f) a reflection electrode formed on said electrically insulating film, and electrically connected to an electrode of said switching device,

wherein a light passing through said second substrate and said liquid crystal layer is reflected at said reflection electrode,

said thin region extends outwardly from said thick region by a certain length at an end of a display region in which images are to be displayed, such that a step
25 formed by said electrically insulating film in the vicinity of said end of said display region is smoothed.

18. The liquid crystal display device as set forth in claim 17, wherein said certain length is in the range of about 10 μ m to about 12 μ m both inclusive.

19. The liquid crystal display device as set forth in claim 17, wherein said thin region has a thickness in the range of about $0.3\mu\text{m}$ to about $1.5\mu\text{m}$ both inclusive.

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20. The liquid crystal display device as set forth in claim 17, wherein said thick region has a thickness in the range of about $1\mu\text{m}$ to about $3\mu\text{m}$ both inclusive.

10 21. The liquid crystal display device as set forth in claim 17, wherein said electrically insulating film is composed of thermo-flexible organic or inorganic material.

22. A liquid crystal display device comprising:

- 15 (a) a first substrate;
- (b) a second substrate facing and spaced away from said first substrate;
- (c) a liquid crystal layer sandwiched between said first and second substrates;
- (d) a switching device formed on said first substrate;
- 20 (e) an electrically insulating film formed on said first substrate, and defined by a thick region and a thin region, said electrically insulating film having a wavy surface; and

(f) a reflection electrode formed on said electrically insulating film, and electrically connected to an electrode of said switching device,

25 wherein a light passing through said second substrate and said liquid crystal layer is reflected at said reflection electrode,

said thin region extends inwardly from said thick region by a certain length at a contact region where said reflection electrode is electrically connected to said electrode of said switching device, such that a step formed by said electrically

insulating film in the vicinity of said contact region is smoothed.

23. The liquid crystal display device as set forth in claim 22, wherein said certain length is in the range of about $10\text{ }\mu\text{m}$ to about $12\text{ }\mu\text{m}$ both inclusive.

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24. The liquid crystal display device as set forth in claim 22, wherein said thin region has a thickness in the range of about $0.3\text{ }\mu\text{m}$ to about $1.5\text{ }\mu\text{m}$ both inclusive.

10 25. The liquid crystal display device as set forth in claim 22, wherein said thick region has a thickness in the range of about $1\text{ }\mu\text{m}$ to about $3\text{ }\mu\text{m}$ both inclusive.

26. The liquid crystal display device as set forth in claim 22, wherein said 15 electrically insulating film is composed of thermo-flexible organic or inorganic material.

27. A method of fabricating a liquid crystal display device, comprising the steps at least of:

20 (a) randomly patterning a first electrically insulating film on a first substrate on which a switching device is fabricated;

(b) covering said first electrically insulating film with a second electrically insulating film; and

25 (c) forming a reflection electrode on a wavy surface of said first and second electrically insulating films such that said reflection electrode is electrically connected to an electrode of said switching device, said reflection electrode reflecting a light passing through both a second substrate facing and spaced away from said first substrate and a liquid crystal layer sandwiched between said first and second substrates,

said step (b) including:

(b1) forming said second electrically insulating film over said first substrate such that said first electrically insulating film is entirely covered with said second electrically insulating film; and

5 (b2) partially removing said second electrically insulating film such that said second electrically insulating film extends outwardly from said first electrically insulating film by a certain length at an end of a display region in which images are to be displayed, thereby a step formed by said first and second electrically insulating films in the vicinity of said end of said display region is smoothed.

10 28. The method as set forth in claim 27, wherein said certain length is in the range of about 10 μ m to about 12 μ m both inclusive.

15 29. The method as set forth in claim 27, wherein said second electrically insulating film has a thickness in the range of about 0.3 μ m to about 1.5 μ m both inclusive.

20 30. The method as set forth in claim 27, wherein said first electrically insulating film has a thickness in the range of about 1 μ m to about 3 μ m both inclusive.

31. The method as set forth in claim 27, wherein said second electrically insulating film is composed of thermo-flexible organic or inorganic material.

25 32. The method as set forth in claim 27, wherein said first and second electrically insulating films are composed of different materials from each other.

33. The method as set forth in claim 27, wherein said first and second electrically insulating films are composed of the same material having different

viscosities from each other.

34. The method as set forth in claim 27, wherein said first and second electrically insulating films are composed of a combination of organic and inorganic materials.

35. The method as set forth in claim 27, wherein said step (c) includes the steps of:

(c1) depositing a material of which said reflection electrode is composed, entirely over said second electrically insulating film;

(c2) coating a resist over said material;

(c3) removing said resist in an area in which said material is to be removed; and

(c4) etching said material with said resist being used as a mask.

36. A method of fabricating a liquid crystal display device, comprising the steps at least of:

(a) randomly patterning a first electrically insulating film on a first substrate on which a switching device is fabricated;

(b) covering said first electrically insulating film with a second electrically insulating film; and

(c) forming a reflection electrode on a wavy surface of said first and second electrically insulating films such that said reflection electrode is electrically connected to an electrode of said switching device, said reflection electrode reflecting a light passing through both a second substrate facing and spaced away from said first substrate and a liquid crystal layer sandwiched between said first and second substrates,

said step (b) including:

(b1) forming said second electrically insulating film over said first substrate

such that said first electrically insulating film is entirely covered with said second electrically insulating film; and

(b2) partially removing said second electrically insulating film such that said second electrically insulating film extends inwardly from said first electrically insulating film by a certain length at a contact region where said reflection electrode is electrically connected to said electrode of said switching device, thereby a step formed by said first and second electrically insulating films in the vicinity of said contact region is smoothed.

37. The method as set forth in claim 36, wherein said certain length is in the range of about $10\text{ }\mu\text{m}$ to about $12\text{ }\mu\text{m}$ both inclusive.

38. The method as set forth in claim 36, wherein said second electrically insulating film has a thickness in the range of about $0.3\text{ }\mu\text{m}$ to about $1.5\text{ }\mu\text{m}$ both inclusive.

39. The method as set forth in claim 36, wherein said first electrically insulating film has a thickness in the range of about $1\text{ }\mu\text{m}$ to about $3\text{ }\mu\text{m}$ both inclusive.

40. The method as set forth in claim 36, wherein said second electrically insulating film is composed of thermo-flexible organic or inorganic material.

41. The method as set forth in claim 36, wherein said first and second electrically insulating films are composed of different materials from each other.

42. The method as set forth in claim 36, wherein said first and second electrically insulating films are composed of the same material having different viscosities from each other.

43. The method as set forth in claim 36, wherein said first and second electrically insulating films are composed of a combination of organic and inorganic materials.

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44. The method as set forth in claim 36, wherein said step (c) includes the steps of:

(c1) depositing a material of which said reflection electrode is composed, entirely over said second electrically insulating film;

10 (c2) coating a resist over said material;

(c3) removing said resist in an area in which said material is to be removed; and

(c4) etching said material with said resist being used as a mask.

15 45. A method of fabricating a liquid crystal display device, comprising the steps at least of:

(a) randomly patterning an electrically insulating film on a first substrate on which a switching device is fabricated, said electrically insulating film having a wavy surface; and

20 (b) forming a reflection electrode on said wavy surface of said electrically insulating film such that said reflection electrode is electrically connected to an electrode of said switching device, said reflection electrode reflecting a light passing through both a second substrate facing and spaced away from said first substrate and a liquid crystal layer sandwiched between said first and second
25 substrates,

said step (b) including:

(b1) forming said electrically insulating film over said first substrate; and

(b2) patterning said electrically insulating film into a removal region in which said electrically insulating film is completely removed, a thin region in

which said electrically insulating film remains as a thin film, and a thick region in which said electrically insulating film remains as a thick film such that said thin region extends outwardly from said thick region by a certain length at an end of a display region in which images are to be displayed, thereby a step formed by said electrically insulating film in the vicinity of said end of said display region is smoothed.

46. The method as set forth in claim 45, wherein said electrically insulating film is patterned in said step (b2) in single exposure to a light through the use of a half-tone mask having a light-permeable portion for defining said removal region, a half-light-permeable portion for defining said thin region, and a light-impermeable portion for defining said thick region.

47. The method as set forth in claim 46, wherein said half-light-permeable portion is located adjacent to said light-permeable portion.

48. The method as set forth in claim 45, wherein said electrically insulating film is patterned in said step (b2) in single exposure to a light through the use of a photo mask having a light-permeable portion for defining said removal region, and a half-light-permeable portion for defining said thin region.

49. The method as set forth in claim 45, wherein said electrically insulating film is patterned in said step (b2) in single exposure to a light through the use of a photo mask having such a fine pattern that a light to be directed to said thin region is attenuated.

50. The method as set forth in claim 45, wherein said certain length is in the range of about $10\text{ }\mu\text{m}$ to about $12\text{ }\mu\text{m}$ both inclusive.

51. The method as set forth in claim 45, wherein said thin region has a thickness in the range of about $0.3\ \mu\text{m}$ to about $1.5\ \mu\text{m}$ both inclusive.

52. The method as set forth in claim 45, wherein said thick region has a
5 thickness in the range of about $1\ \mu\text{m}$ to about $3\ \mu\text{m}$ both inclusive.

53. The method as set forth in claim 45, wherein said electrically insulating film is composed of thermo-flexible organic or inorganic material.

10 54. The method as set forth in claim 45, wherein said step (c) includes the steps of:

(c1) depositing a material of which said reflection electrode is composed, entirely over said second electrically insulating film;

(c2) coating a resist over said material;

15 (c3) removing said resist in an area in which said material is to be removed;
and

(c4) etching said material with said resist being used as a mask.

20 55. A method of fabricating a liquid crystal display device, comprising the steps at least of:

(a) randomly patterning an electrically insulating film on a first substrate on which a switching device is fabricated, said electrically insulating film having a wavy surface; and

25 (b) forming a reflection electrode on said wavy surface of said electrically insulating film such that said reflection electrode is electrically connected to an electrode of said switching device, said reflection electrode reflecting a light passing through both a second substrate facing and spaced away from said first substrate and a liquid crystal layer sandwiched between said first and second substrates,

said step (b) including:

(b1) forming said electrically insulating film over said first substrate; and

(b2) patterning said electrically insulating film into a removal region in which said electrically insulating film is completely removed, a thin region in which said electrically insulating film remains as a thin film, and a thick region in which said electrically insulating film remains as a thick film such that said thin region extends inwardly from said thick region by a certain length at a contact region where said reflection electrode is electrically connected to said electrode of said switching device, thereby a step formed by said electrically insulating film in the vicinity of said contact region is smoothed.

56. The method as set forth in claim 55, wherein said electrically insulating film is patterned in said step (b2) in single exposure to a light through the use of a half-tone mask having a light-permeable portion for defining said removal region, a half-light-permeable portion for defining said thin region, and a light-impermeable portion for defining said thick region.

57. The method as set forth in claim 56, wherein said half-light-permeable portion is located adjacent to said light-permeable portion.

58. The method as set forth in claim 55, wherein said electrically insulating film is patterned in said step (b2) in single exposure to a light through the use of a photo mask having a light-permeable portion for defining said removal region, and a half-light-permeable portion for defining said thin region.

59. The method as set forth in claim 55, wherein said electrically insulating film is patterned in said step (b2) in single exposure to a light through the use of a photo mask having such a fine pattern that a light to be directed to said thin region is attenuated.

60. The method as set forth in claim 55, wherein said certain length is in the range of about $10\text{ }\mu\text{m}$ to about $12\text{ }\mu\text{m}$ both inclusive.

5 61. The method as set forth in claim 55, wherein said thin region has a thickness in the range of about $0.3\text{ }\mu\text{m}$ to about $1.5\text{ }\mu\text{m}$ both inclusive.

62. The method as set forth in claim 55, wherein said thick region has a thickness in the range of about $1\text{ }\mu\text{m}$ to about $3\text{ }\mu\text{m}$ both inclusive.

10 63. The method as set forth in claim 55, wherein said electrically insulating film is composed of thermo-flexible organic or inorganic material.

15 64. The method as set forth in claim 55, wherein said step (c) includes the steps of:

 (c1) depositing a material of which said reflection electrode is composed, entirely over said second electrically insulating film;

 (c2) coating a resist over said material;

 (c3) removing said resist in an area in which said material is to be removed;

20 and

 (c4) etching said material with said resist being used as a mask.